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Plasma-based diagnostics of High-Brightness Electron Beams at the frontier of Temporal and Spatial Resolution

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We present a novel diagnostics to characterize high brightness electron beams. The technique, based on the tunnel ionization of a neutral gas by the intense (GV/m) self-field of the electron beam, can be used to measure the volumetric charge density of the beam; e. g. to reconstruct pulse durations shorter than few femtoseconds or to measure transverse beam sizes below the micron level. Results from analytical (Ammosov Delone Krainov (ADK) model) and particle-in- cell code simulations will be discussed up to beam durations that approach the through-the- barrier tunneling times, where deviations from the ADK model are expected. Experiments with sub femtosecond unipolar self-field of electron beam, could further deepen our understanding of quantum tunneling process. We finally present practical implementation of this new diagnostics at LCLS, in the XLEAP* experiment, and laser plasma accelerator BELLA.

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